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Turbulent spots in high-speed boundary layers

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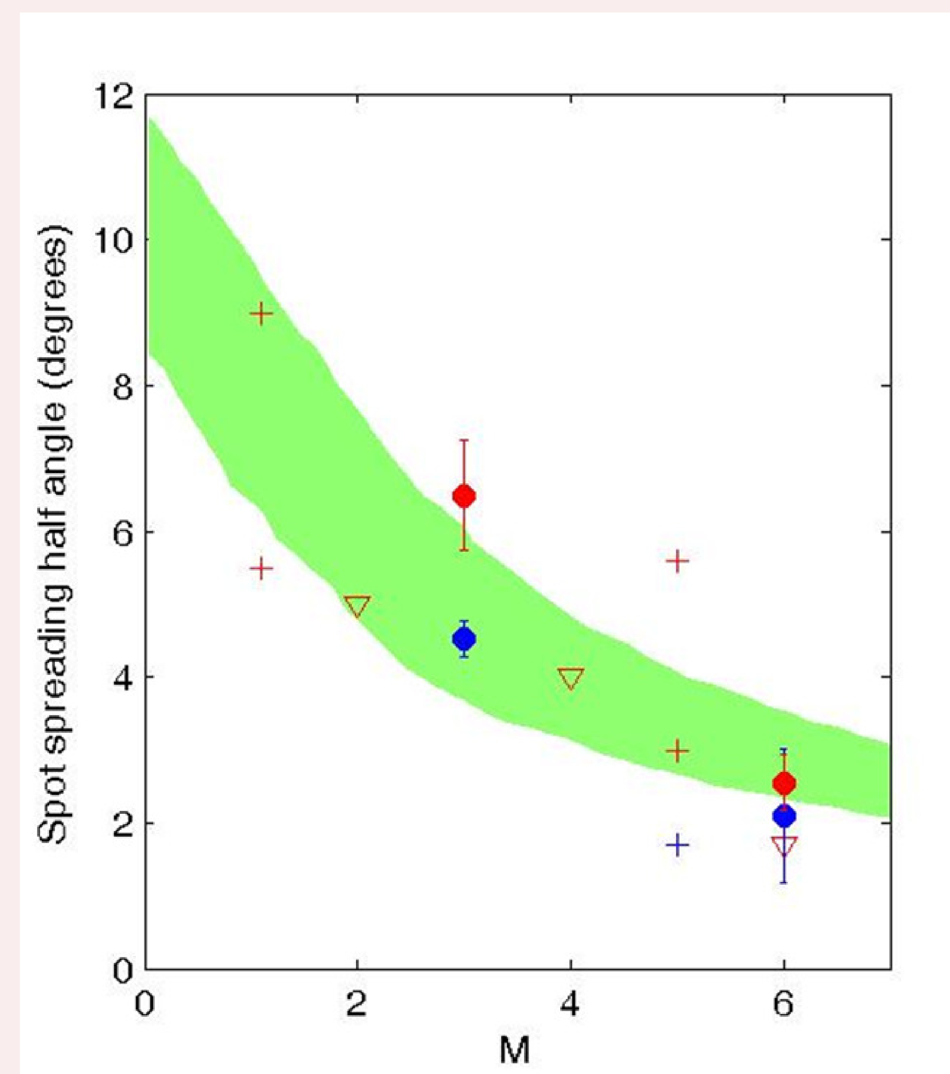
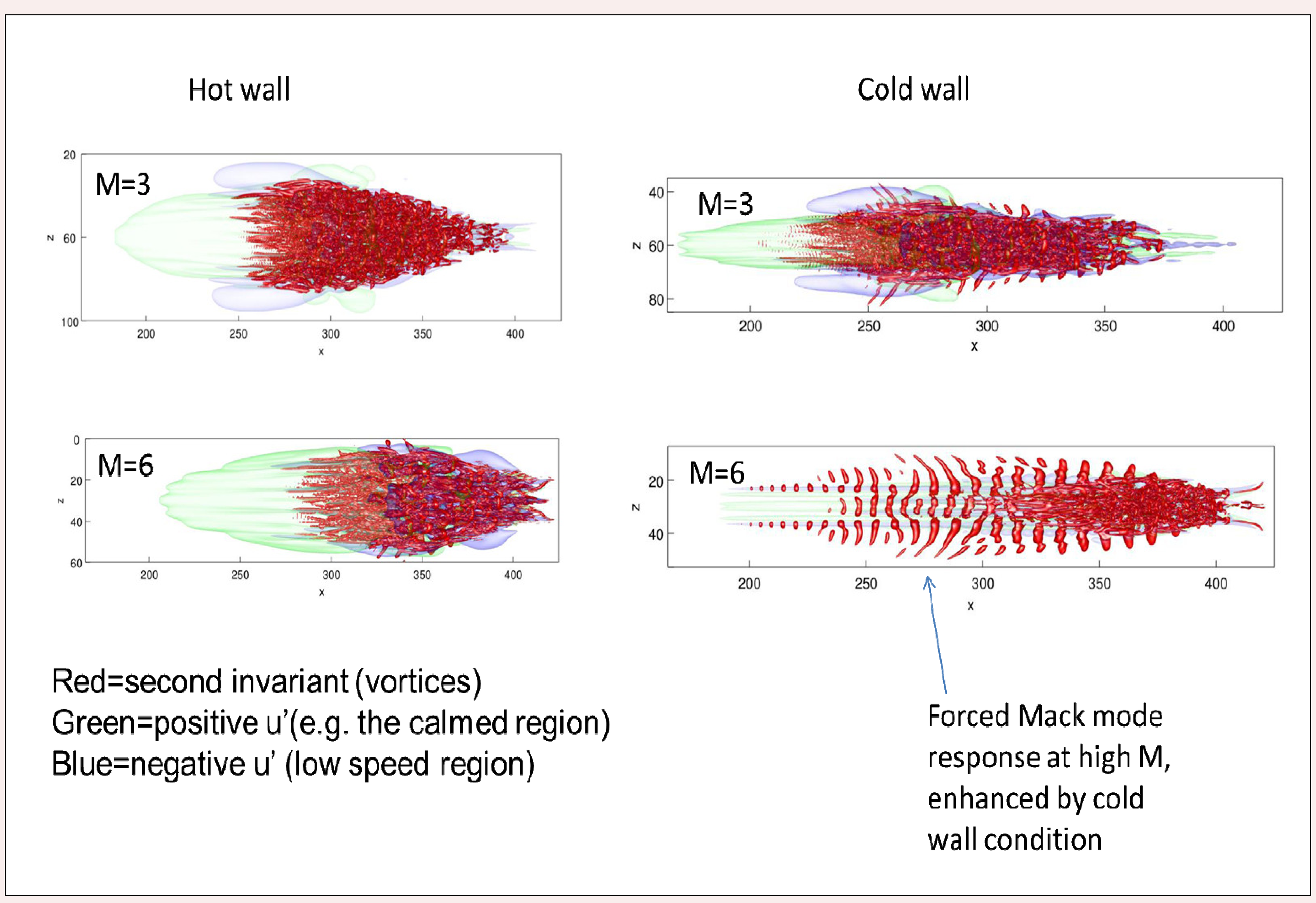
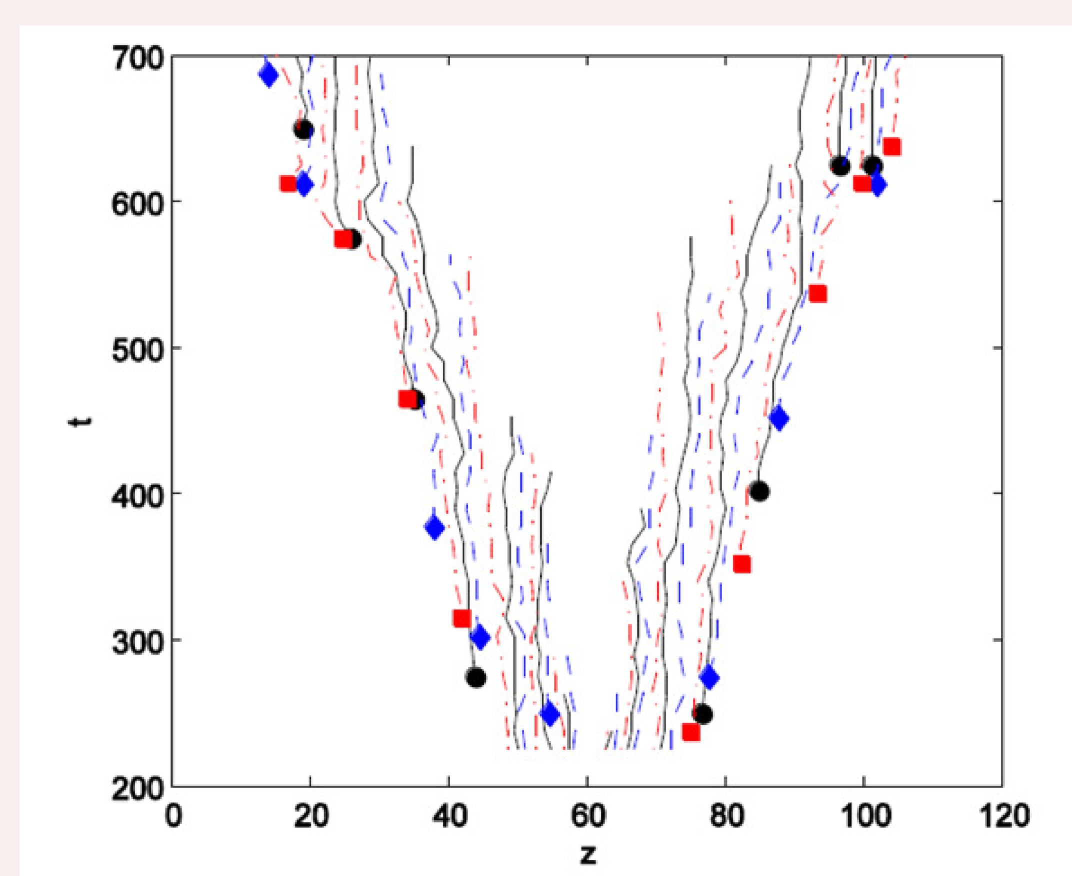
In a high disturbance environment, transition to turbulence is characterised by the growth and merging of turbulent spots. Transition is particularly important in practical applications in high speed aerodynamics since surface heating is much higher in turbulent flow. In this work the effect of Mach number and surface temperature has been investigated using direct numerical simulation, whereby all the scales in the flow are resolved.

Very strong compressibility effects are observed, with large reductions in spot growth rate and significant changes in spot structure. Of the two mechanisms for spot growth, namely lateral advection and flow destabilisation, it appears that the latter is the one that is significantly damped with increasing Mach number. Wall cooling is found to also have a stabilising effect.



Variation of spot lateral growth rate with Mach number, with the green region showing the range of experimental data and the symbols showing recent simulation data.





Tracking of structures at the edge of the spot.

References:

Krishnan, L., Sandham, N.D. (2006) Effect of Mach number on the structure of turbulent spots, *Journal of Fluid Mechanics,* **566**, 225-234

Redford, J.A., Sandham, N.D. and Roberts, G.T. (2011) Numerical simulations of turbulent spots in supersonic boundary layers: Effects of Mach number and wall temperature, *Progress in Aerospace Sciences*. (in press)

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